



JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Weekly CEA FM Seminar: Spring 2013

Date: **Friday, March 29, 2013**

Time: 11:00 AM

Location: Gilman 50 (Marjorie M. Fisher Hall)

Speaker: **DR. RAÚL BAYOÁN CAL** (Portland State University)

Title: ***"STATISTICAL ANALYSIS OF A MODEL WIND TURBINE ARRAY BOUNDARY LAYER"***

Abstract

A wind turbine array was created for the purpose of investigating wake interaction and atmospheric boundary layer recovery dynamics given standard Cartesian and row-offset configurations. The snapshot proper orthogonal decomposition is applied to velocity measurements. Resulting POD modes are used in constructing low dimensional models of turbulent statistics including turbulence production and the flux of kinetic energy. Convergence for low-dimensional models determined by the absolute span of the streamwise average profile of the Reynolds stress. Models demonstrate that the flux of kinetic energy and turbulence production are accurately rebuilt with approximately 1% of the total resultant POD modes. Additionally, structures associated with the top-tip of the rotor blade reconstruct with fewer modes than those associated with the bottom-tip of the rotor or the nacelle. This demonstrates that the greatest part of the turbulent energy is located high in the turbine canopy. Other statistical representations of the wind turbine array boundary layer will be assessed.

Bio

Dr. Cal is an assistant professor in the Department of Mechanical and Materials Engineering at Portland State University. He also holds an appointment as visiting professor at Johns Hopkins University. He received his B.S., M.S. and Ph.D. in Mechanical Engineering from Rensselaer Polytechnic Institute in Troy, NY in 2001, 2003, and 2006, respectively. He also holds another M.S. Degree in Experimental and Computational Turbulence from Chalmers University of Technology attained in 2006. During 2006 to 2008, he was a postdoctoral fellow at Johns Hopkins University. Dr. Cal joined Portland State faculty in 2009. Dr. Cal's area of research is focused on understanding hydrodynamic turbulence and complexity in fluid mechanics in general. He uses theoretical and experimental tools to assess the behavior of the flow. Emphasis is placed on topics such as interactions of wind turbine arrays and urban canopies with the atmospheric boundary layer as well as external effects on the turbulent boundary layer such as pressure gradient, surface roughness and incoming turbulence levels. Experimental techniques such as particle image velocimetry, laser Doppler velocimetry and hot-wire anemometry are used to quantify such flows in scaled environments.